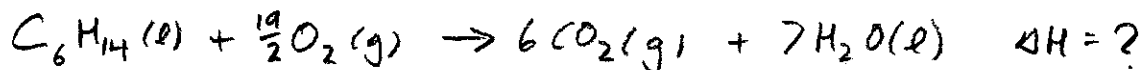


1

Name: _____

SCH 4U Thermodynamics Test

1. Determine the heat of combustion of hexane given that 15.0 g of hexane (C_6H_{14}) can warm 25.000 l of water from 25.000 °C to 31.925 °C. DO NOT USE THE TABLES IN THE BOOK FOR THIS QUESTION (accept to perhaps check your answer)!!! Note that this is a multi-step problem - use appropriate format.



$$Q = mc\Delta T$$

$$Q = 25000g \times 4.184J/g^\circ C \times (31.925 - 25.000)^\circ C$$

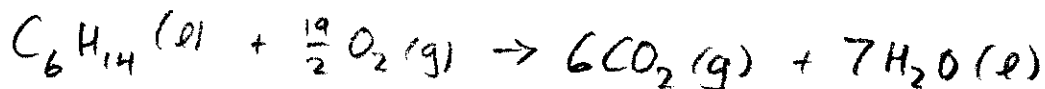
$$Q = 724355 J$$

$$Q = 724.355 kJ$$

$$\frac{724.355 kJ}{15.0g C_6H_{14}} \times \frac{86.2g C_6H_{14}}{1mol C_6H_{14}} = 4162.627 kJ/mol C_6H_{14}$$

$$\Delta H = -Q$$

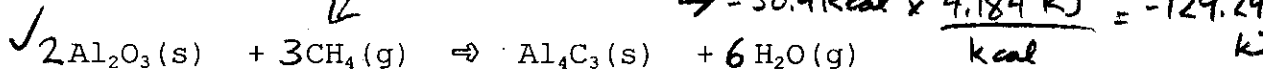
$$\Delta H = -4162.627 kJ/mol C_6H_{14}$$



$$\Delta H = -4162.627 kJ$$

1

2. Using heats of formation from pg 799 in your text and that $\Delta H^\circ_{\text{Al}_2\text{O}_3(s)} = -1866.44 \text{ kJ}$ and $\Delta H^\circ_{\text{Al}_4\text{C}_3(s)} = -30.9 \text{ kcal}$ determine the heat of reaction for:



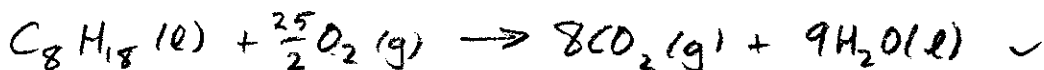
$$\checkmark \Delta H = [\Delta H^\circ_{\text{Al}_4\text{C}_3(s)} + 6\Delta H^\circ_{\text{H}_2\text{O}(g)}] - [2\Delta H^\circ_{\text{Al}_2\text{O}_3(s)} + 3\Delta H^\circ_{\text{CH}_4(g)}]$$

$$\checkmark \Delta H = [-129.29 \text{ kJ} + 6(-241.8 \text{ kJ})] - [2(-1866.44 \text{ kJ}) + 3(-74.4 \text{ kJ})]$$

$$\checkmark \Delta H = 2375.99 \text{ kJ}$$

3

3. The heat of combustion of octane ($\text{C}_8\text{H}_{18}(l)$) is -5470.1 kJ . Use $\Delta H^\circ_{\text{CO}_2(g)} = 393.5 \text{ kJ}$, $\Delta H^\circ_{\text{H}_2\text{O}(l)} = 285.8 \text{ kJ}$ and the heat summation rule to determine the heat of formation of octane. Once again DO NOT USE THE TABLES IN THE BOOK FOR THIS QUESTION (accept to perhaps check your answer)!!!



4.

$$\Delta H = [8\Delta H^\circ_{\text{CO}_2(g)} + 9\Delta H^\circ_{\text{H}_2\text{O}(l)}] - [\Delta H^\circ_{\text{C}_8\text{H}_{18}(l)} + \frac{25}{2}\Delta H^\circ_{\text{O}_2(g)}] \checkmark$$

$$-5470.1 \text{ kJ} = [8(-393.5 \text{ kJ}) + 9(-285.8 \text{ kJ})] - [\Delta H^\circ_{\text{C}_8\text{H}_{18}} + \frac{25}{2}(0)] \checkmark$$

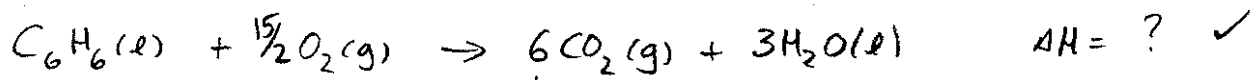
$$\Delta H_{\text{C}_8\text{H}_{18}} = -5720.2 \text{ kJ} + 5470.1 \text{ kJ}$$

$$\Delta H_{\text{C}_8\text{H}_{18}} = -250.1 \text{ kJ} \checkmark$$

7

①

4. Determine the mass of steam produced by the heating of 500 mL of water starting at 20 °C by the thorough combustion of 5.0 ~~10.0~~ g of benzene ($C_6H_6(l)$). Try pg 799 & 307 for relevant values. Do not use Hess' Law



$$\Delta H = [6\Delta H^\circ_{CO_2(g)} + 3\Delta H^\circ_{H_2O(l)}] - [\Delta H^\circ_{C_6H_6(l)} + \frac{15}{2}\Delta H^\circ_{O_2(g)}] \quad \checkmark$$

$$\Delta H = [6(-393.5 kJ) + 3(-285.8 kJ)] - [49.0 kJ + \frac{15}{2}(0)] \quad \checkmark$$

$$\Delta H = -3267.4 kJ \quad \checkmark$$

$$Q = -\Delta H \quad \checkmark$$

$$Q = 3267.4 kJ / \text{mol } C_6H_6(l) \quad \checkmark$$

1a

$$5.0 g C_6H_6 \times \frac{1 \text{ mol } C_6H_6(l)}{78.12 g C_6H_6(l)} \times \frac{3267.4 kJ}{1 \text{ mol } C_6H_6(l)} = 209.127 kJ \quad \checkmark$$

available heat
↓

$$Q = mc\Delta T \quad \checkmark$$

$$Q = 500 g \times 4.184 J/g^\circ C \times 80^\circ C \quad \checkmark$$

$$Q = 167360 J \quad \checkmark$$

$$Q = 167.360 kJ \quad \checkmark \leftarrow \text{heat required to warm water}$$

$$\text{available} - \text{required} = \text{remaining} \quad \checkmark$$

$$209.127 kJ - 167.360 kJ = 41.767 kJ \text{ remaining (to produce steam)} \quad \checkmark$$

$$Q = Lv m \quad \checkmark$$

$$m = \frac{Q}{Lv}$$

$$m = \frac{41.767 kJ}{40.8 kJ} \times \frac{1 \text{ mol}}{18.02 g} \quad \checkmark$$

$$m = 18.447 g \quad \checkmark$$

1a

5. Using Hess' Law determine heat of formation of urea, $\text{CO}(\text{NH}_2)_2(\text{s})$ from the following information:

- ① the heat of formation of ammonia, $\text{NH}_3(\text{g})$ is -45.9 kJ
- ② the heat of combustion of acetic acid, $\text{CH}_3\text{COOH}(\text{l})$ is -925.8 kJ
- ③ the heat of formation of methane ($\text{CH}_4(\text{g})$) is -74.4 kJ
- ④ $\text{CO}(\text{NH}_2)_2(\text{s}) + \text{H}_2\text{O}(\text{l}) + \text{CH}_4(\text{g}) \rightleftharpoons \text{CH}_3\text{COOH}(\text{l}) + 2\text{NH}_3(\text{g}) \quad \Delta H^\circ = 169.1 \text{ kJ}$
- ⑤ the heat of formation of $\text{CO}_2(\text{g})$ is -393.5 kJ
- ⑥ the heat of formation of $\text{H}_2\text{O}(\text{l})$ is -285.8 kJ

